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REPORT

The Impact of Regional Free Trade Agreements on the Vietnamese Agricultural Sector and Regional Economies

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The Impact of Regional Free Trade Agreements on the Vietnamese Agricultural Sector and Regional Economies

Tom Kompas[a,b,*], Pham Van Ha[a], Hoa Thi Minh Nguyen[a], Long Chu[a]

[a] *Crawford School of Public Policy, Crawford Building (132), Lennox Crossing, Australian National University, Canberra, 2601, ACT*

[b] *Centre of Excellence in Biosecurity Risk Analysis, University of Melbourne, Melbourne, 3010, VIC*

Abstract

This report builds an intertemporal version of a GTAP model and uses it in combination with a Vietnamese intertemporal and regional Computable General Equilibrium (CGE) model to analyse the impacts of regional Free Trade Agreements (FTAs), most importantly the Trans-Pacific Partnership (TPP) and the EU-Vietnam FTA, on regional economies in Vietnam and the agricultural sector. Our results show that Vietnam gains most from the current implementation of FTAs. Nevertheless, even though the country's GDP will increase with FTAs, the results for agricultural commodities are mixed: some gain, some lose. Our model also predicts a challenging time ahead for exports of all agricultural commodities. The gains in output, in particular, of some agricultural sectors are due largely to overall economic (or income) growth, and not from added international competitiveness in export markets. In terms of employment, labour absorption of the expanding sector in the model (i.e., textiles) ensures added job creation in the long run.

Keywords: intertemporal CGE model; regional CGE model; GTAP; Free Trade Agreement; Vietnam.

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*Corresponding author: Tom Kompas, Crawford School of Public Policy, Crawford Building (132), Australian National University, Canberra, ACT, 2601, Australia. Email: tom.kompas@anu.edu.au; Phone: +61 2 6125 0507.

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1. Introduction

Vietnam began its dramatic reform process, moving from a centrally planned closed economy in 1986. Four years later, Vietnam signed its first trade deal with a Western partner: a textile trade agreement with the EU (Delegation of the European Union to Vietnam, 2015). Since then, Vietnam has quickly integrated into the world economy: it gained ASEAN membership in 1995 (Association of Southeast Asian Nation, 2015), signed a bilateral trade agreement with the US in 2001 (Embassy of the United States, Hanoi, Vietnam, 2015) and eventually joined the WTO in 2007 (World Trade Organisation, 2015). Vietnam, in other words, quickly turned itself from a closed economy to a very open economy with annual growth in export and import turnovers averaging 20.6% and 16.7% respectively during the period from 1986-2014 (see Table 1), and a total export-import turnover ratio to GDP of 154.5% in 2014 (Asian Development Bank, 2015). Currently, Vietnam has a trade relationship with more than 200 countries and regions in the world (General Statistics Office, 2006).

Table 1: Total export-import turnover and balance of trade

	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2014
Total export-import volume (Mil. USD)	19717	39940	113440	240981	623562	994266
Annual growth rate (%)	15.1	21.4	17.2	18.2	19	17.4
Exports	7032	17156	51825	110830	280405	493654
Annual growth rate (%)	28	17.8	21.6	17.5	18.3	20.1
Imports	12685	22784	61615	130151	343158	500612
Annual growth rate (%)	8.2	24.3	13.9	18.8	19.7	14.9
Balance of Trade	-5653	-5628	-9789	-19321	-62753	-6957

Source: General Statistics Office (2006); General Statistical Office (2010*c*, 2013, 2015).

Economic integration has also brought about strong economic growth with an annual growth rate of 7% in the period from 1991-2014 (Asian Development Bank, 2006, 2015).

However, economic integration also brings competition and the agricultural sector is one of the most vulnerable, especially the livestock sector, which is typical dominated by small scale (family) production. The introduction of international competition to the agricultural sector is of special concern as it employs 70-80% of the country's labour force. The completion of the TPP negotiation, again brings forward legitimate concerns: a hope for added economic growth for the whole country, but a concern for the economic health of the agricultural sector.

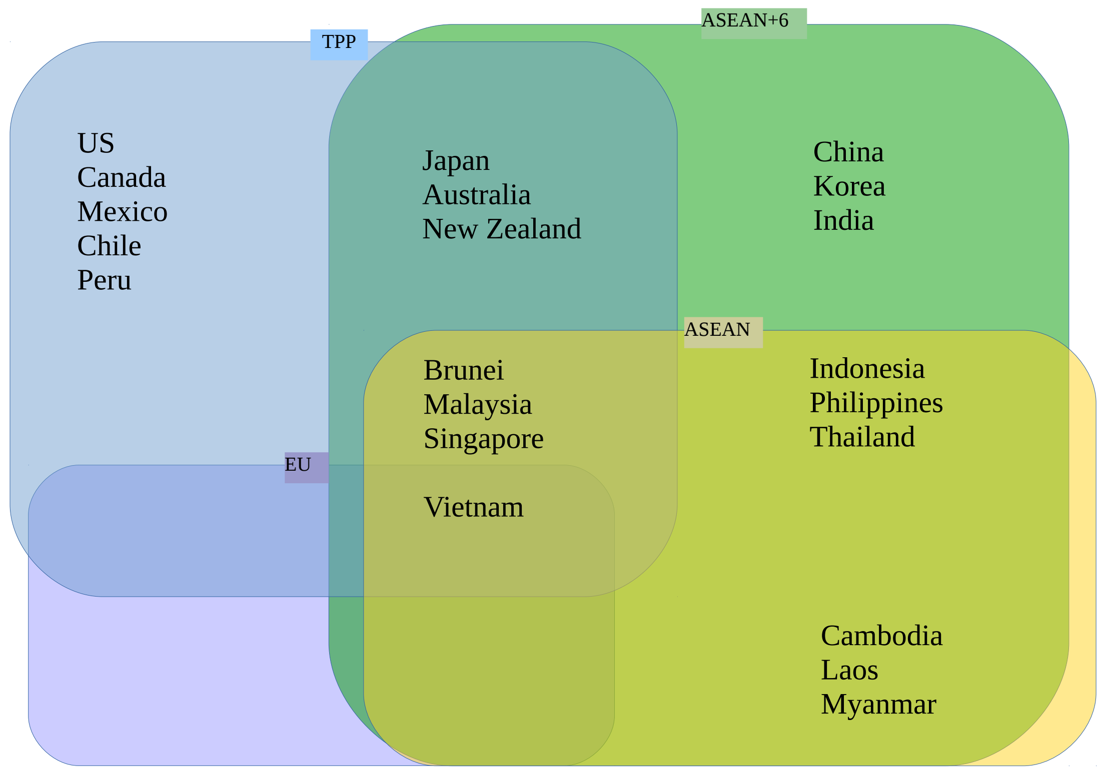
The purpose of this report is to evaluate the impact of the FTAs, especially TPP, on the Vietnamese economy, with the focus on regional economies and the agricultural sector in the next 5-10 (or more) years. To accomplish this, the report will provide:

- An overall assessment of the various future bilateral and multilateral FTAs and their effects on the Vietnamese economy.
- A regional CGE model for an assessment of the impact of FTAs on the Vietnamese economy.
- A detailed assessment of the impact of FTAs on selected regional agricultural sectors over the next decade.

2. Vietnam and Regional FTAs

In contradistinction with the closed and planned economy of some 25 years ago, Vietnam has became a very open economy today with clearly defined benefits from that move. Over the same time period, free trade deals have been completed and under implementation by Vietnam with ASEAN, China, Korea, Japan, Australia, New Zealand, India, and most recently talks are underway for a possible TPP and Vietnam-EU free trade agreement. Although having a trade relationship with more than 200 countries and regions, most of Vietnam's important free trade negotiations are regional and can be classified into four broad frameworks (see Fig 1): (1) Association of Southeast Asian Nations (ASEAN) Trade in Goods Agreement (ATIGA) — a free trade agreement among 10 ASEAN member countries (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Vietnam, Thailand); (2) ASEAN+6: free trade agreement between 10 ASEAN countries and China, Korea, Japan, India, Australia and New-Zealand and (3) TPP: free trade agreement between 12 member countries (Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, USA, and Vietnam); and (4) EU-Vietnam FTA (EVFTA): free trade agreement between Vietnam and the EU.

Figure 1: Regional FTAs involving Vietnam



Source: Authors.

With the exception of the TPP (under negotiation), the tariff reduction schedule for nearly all of the current (under implementation) regional FTAs are nearly finished or more than half-way completed for ASEAN-6 countries (Brunei, Indonesia, Malaysia, Philippines, Singapore, Thailand), and with some flexibility for Cambodia, Laos, Myanmar (CLM), and Vietnam. In particular, the following have been achieved:

- ATIGA: ASEAN-10. Import duties on all products (with some exceptions) to be eliminated by 2010 for ASEAN-6 and by 2015 (with flexibility to 2018) for Vietnam, Laos, Cambodia and Myanmar. Currently, ASEAN-6 have eliminated 99.65% of their tariff lines, while Vietnam, Laos, Cambodia and Myanmar have reduced their import duties to 0-5 percent on 98.86% of their tariff lines.
- ASEAN+6:
  - ACFTA: China and ASEAN. Scheduled reductions: China 2010-2012, other ASEAN countries, on average, from 2010-2018.
  - AANZFTA: Australia, New-Zealand and ASEAN. Scheduled: 2009-2025.
  - AIFTA: India and ASEAN. Schedule begins in 2010 and is expected to end in 2013-2019 and to 2021 for ASEAN-6, India and Vietnam, Laos, Cambodia and Myanmar.
  - AKFTA: Korea and ASEAN. Tariff reduction started in 2009. ASEAN 6 and Korea have finished their tariff reductions (normal track). For Vietnam, the tariff reduction schedule is expected to end in 2018, with Cambodia, Laos, and Myanmar reducing until 2020.
  - AJCEP: Japan and ASEAN. Tariff reduction schedule started in 2008 and is expected to end before 2026 (for Cambodia, Laos, Myanmar).
- TPP-12: Schedule begins in 2018 and is expected to end within the next 10-25 years.
- EVNFTA: Vietnam EU FTA. Scheduled: 2017-2027.

3. Related literature

Free trade agreements affect both the supply and demand sides of the economies involved over an extensive time period, as tariff reduction schedules are slowly implemented to avoid immediate and disruptive impacts to economic activities. Therefore, regional and dynamic CGE models are the natural choice for trade impact analysis. In this section, we briefly review recent trade analysis work using CGE models. We also and pay special attention to works which have been done for Vietnam.

3.1. Single country vs regional CGE models

In terms of single country and regional CGE models, both have pros and cons. While single country models have advantages in their simplicity they can not provide the feedback effect from the trading partner to the country being analysed, or model the feedbacks from the domestic regional economy or from other countries which are not in the FTA. Regional CGE models can capture these regional effects, but their often small dimension means that structures and industries are highly aggregated and simplified. There a number of free trade models available for Vietnam, based on single country CGE models, all with different levels of complexity:

- One of the first CGE attempts for Vietnam was the work by Chan and Dung (2001). Chan and Dung (2001) examined a hypothetical tariff reform, which mimics a free trade commitment for Vietnam in a small open, price-taking CGE model. Chan and Dung's 2001 model consists of 4 blocks with 10 households, 33 producers (sectors), government and the rest of the world (ROW). The household and producers form their demands and production decisions by a combination of Constant Elasticity of Substitution (CES) functional forms and a standard Armington assumption (Armington, 1969). The government in the model is simply there for collection of taxes (and tariffs) and transfers to households. The rest of the world block is for foreign trade: the economy can supply any amount of a good at an exogenously fixed world price. The model evaluates the impact of trade liberalization reform proposed in the second phase of the Vietnamese Ministry of Finance's fiscal reform. Simulation results from the model show that reform brings modest efficiency gains (0.28 % of income), but incurs a significant redistribution cost: the two richest household groups gain while medium income groups generally lose.

- Another notable single country CGE analysis is the accessement of Vietnam's accession to the WTO by Roland-Holst et al. (2002). Roland-Holst et al.'s 2002 model is more complicated than Chan and Dung's 2001 model, given its 'dynamic' structure. It includes a single household, 18 industries (commodities), a government and the rest of the world blocks. The production block identifies three types of production: crop, livestock, and other goods and services. Similar to Chan and Dung's 2001 model, all three types of production have a CES nested production structure. The representative household distributes income between final good consumption and savings based on an extended linear expenditure system. In turn, a household's final good consumption is divided between domestic and imported goods by an Armington assumption and a CES function form. The government collects taxes and its consumption is proportional to GDP. The export or ROW block is formed by a nest of constant elasticity of transformations (CET): producers first choose to sell product domestically or internationally based on a CET functional form, exports are then redistributed among trading partners based on price differentials, also with a CET functional form. The model solves recursively over the period 2000-2020.

- In a way different from the above two models, Huong's 2003 model follows a generic 'template' for CGE modelling, using an ORANI model, Dixon et al. (1982); Horridge (2003), which also relies on an Armington assumption (Armington, 1969) to build nested demand and supply sides of the economy. Huong (2003) simulates the free trade situation by reducing all of Vietnam's tariffs by 5% and considers two government policies to cope with revenue reduction: raising indirect taxes and external borrowing. By raising indirect taxes, government will lower the benefit of free trade reform, i.e., the economy grows, in other words, at lower rate and households gain less; but, most importantly, free trade will improve equality among households. In the external borrowing scenario, households can reach higher welfare levels, although Huong (2003) warns this result should be treated carefully since it does not take into account the rise in debt levels. Inequality, however, rises in the second scenario.

- Toan's 2007 model, on the other hand, exploits the single country simplicity to expand the model over time to build a dynamic (intertemporal) CGE model. Unlike the static models, a consumer in Toan (2007) maximises its utility over the long run subject to debt accumulation, while producers maximise profits over the long run subject to a convex investment function. The model also has five different household groups and 12 labour groups. Among other things, the model can analyse the impact of free trade on household welfare both by household groups and over time. It shows that the welfare of household groups increase in the long run, but inequality can also increase at the same time.

As we can see from the above, despite the lack of external feedbacks, a single country model can detail effects on household groups and labour types and evaluate the inequality outcomes of FTAs. Nevertheless, they are bound to a single country analysis, in a world, with FTAs, that go far beyond single country effects. Clearly, a more general approach is needed.

Multi-regional or global CGE models, on the other hand, are a combination of single country models, or models with endogenous ROW effects. Instead of having endogenously downward slopping foreign demand functions, the export of a country in a global model will be the sum of all import demands for the country's commodities from all the other countries in the model. There are many global CGE models available, for example GTAP Hertel (1997), G-CUBED McKibbin and Wilcoxen (1999), and MIRAGE Bchir et al. (2002). However, due to the lack of data and computational issues, only GTAP and MIRAGE have been successively used for trade analysis for Vietnam.

The MIRAGE model, in particular, has been used for an ex-post evaluation of Vietnam's accession to the WTO (Boumellassa and Valin, 2009). The MIRAGE model is built on

GTAP's database, but varies from GTAP in three ways: (1) it models FDI explicitly; (2) it models product differentiation; and (3) it relies on the MAcMaps (Bouët et al., 2002) [cited in (Bchir et al., 2002)] trade barriers database (Bchir et al., 2002). The version of the MIRAGE model in (Boumellassa and Valin, 2009) includes 11 regions and 26 commodities (activities). To account for the specific case of Vietnam, the model allows dual production: for domestic sale and for export. The model is solved recursively for the period from 2001-2015 with no WTO accession (for Vietnam) as the base line scenario, in order to compare it to a solution for the case of a WTO accession. The work shows that the WTO accession has a positive impact on the Vietnamese economy with welfare gains around 1%, mainly through the benefits of ending textile quotas from the USA.

The GTAP model has been used for the evaluation of the economic impacts of a WTO accession for Vietnam from as early as 2001 (Fukase and Martin, 2001). The model has gained even more popularity in Vietnam when the country joined the TPP negotiation with the works by Petri et al. (2012); Itakura and Lee (2012); Areerat et al. (2012); Kawasaki (2015). GTAP is a global economy model, which (currently) includes 140 countries and regions and 57 commodities (Narayanan et al., 2015). Similar to MIRAGE, the GTAP model allows a simulation of free trade reform for a group of economies (12 countries in the case of the TPP for example) simultaneously. Imports to a country can come from anywhere in the world, within a maximum set of 139 countries and regions, and the country can sell its product to any country in the same set, with consumers and producers responding to any price fluctuation. Therefore, the model allows us to examine feedbacks from countries in a FTA as well as those outside the FTA. Simulation results from Petri et al. (2012); Itakura and Lee (2012); Areerat et al. (2012); Kawasaki (2015) show that Vietnam has relatively large net gains from the TPP deal. Depending on assumptions in terms of the removal of the non-tariff barriers, the GDP gain for Vietnam can vary: Petri et al. (2012) 13.5%; 9.9% (Kawasaki, 2015) to 5.6% (Itakura and Lee, 2012); and 2.4% (Areerat et al., 2012).

However, global economy models, such as MIRAGE and GTAP, have one serious drawback. They are dimensionally small, given the complexity of modelling all interactions at once, and thus they cannot model systems with more household types or added regions within a given country. Regional effects within Vietnam, in particular, can not be accounted for.

3.2. Recursive versus perfect foresight dynamic CGE models

To smooth out the shock for trading economies, free trade liberalisation is always designed as a gradual process, in which tariff rates between countries are removed over a certain period of time (e.g., as long as a decade), and not as a once-off move. In that case, the conventional short and long run CGE switching approach where the capital is fixed in the short run, and free in the long run, is no longer adequate. Dynamic CGE modelling is, therefore, a natural way to simulate free trade agreements. The dynamic CGE modelling approach allows capital (as a production factor) to accumulate (or de-accumulate) after every period of time, where capital accumulation equals investment minus depreciation. There are two approaches to dynamic CGE modelling: the recursive method and the perfect foresight method. Each has its own advantages and drawbacks.

Perfect foresight (or intertemporal) dynamic CGE models solve the producer's (as well as consumer's) problem in the long run, where the model assumes the producer and representative consumer can live forever and optimise their profit (utility) over the long run subject to capital accumulation (and debt) constraints. Most of the intertemporal models solve the producer and consumer problem by setting up a Hamiltonian function and its solution will be a typical saddle path backward-forward differential (or difference) equation [see, for example, 5SECT model (Chapter 5 Dixon et al., 1982), C-CUBED mode (McKibbin and Wilcoxen, 1999; McKibbin and Sachs, 1991), and for Vietnam (Toan, 2007; Ha and Kompas, 2009)]. The forward and backward equations (together with other intra-period equations) are then solved by a finite differencing method (see Dixon et al., 1982) for all periods simultaneously. To complete the system two terminal conditions for each pair of the forward-backward equations will be set, usually the initial stock (capital or debt) value and zero growth at the end of the time horizon (usually chosen to be very large).

The term 'perfect foresight property' comes from the backward equation and the fact that the model should be solved simultaneously for every (chosen finite difference scheme) time period (see Chapter 5 Dixon et al., 1982). In the case of a typical producer (see Equation 8), the shadow price of capital will depend on the next period shadow price of capital. Solving the problem in period zero requires a solution for the shadow price of capital in period one and so on. Therefore, by solving every period simultaneously, we practically assume the producer can see shadow prices in the future, as if there is perfect foresight.

The drawback of an intertemporal CGE model is that model size is very large since we need to solve every year simultaneously. Currently, solutions are feasible only when the underlying model is small (Dixon et al., 2005). Dixon et al. (2005) has claimed that with over 100 industries it is impossible to solve the model with more than five periods.

To avoid solving all the periods simultaneously, the recursive method solves the model forward by guessing the future period shadow price (or by forming an expectation of it). The guess can be very naive: based on the current period information only (adaptive expectations), or it can be adjusted in a 'shooting approach', where we can adjust our guesses until convergence is archived. The recursive CGE model has been extensively used in free trade analysis in Vietnam (Boumellassa and Valin, 2009; Petri et al., 2012; Itakura and Lee, 2012; Areerat et al., 2012; Kawasaki, 2015).

Although in theory, the solution from the shooting method can converge to the intertemporal solution, Dixon et al. (2005) shows that the shooting method is disappointing in practice. Instead, Dixon et al. (2005) proposed some iterative rational expectations approach where the next iteration of a price guess will be adjusted based on previous iterative values. With the appropriate adjustment coefficient, Dixon et al. (2005) claims that the iterative process can converge relatively quickly, allowing them to solve a model over 20 years, with a rational-expectation policy application for the 113 industry version of the MONASH model (Dixon and Rimmer, 2002), in about 10 hours.

Despite the fact that recursive method can convert large intertemporal CGE models into smaller static models, the recursive method also has its own unique drawbacks. The naive guessing approach is clearly deficient since there is no guarantee that the solution is optimal over the long run. The shooting and rational-expectations policy approach can provide theoretically consistent solutions to the intertemporal model, however, its recursive nature means the model must be solved recursively, period after period, making it hard to employ parallel-processing resources for performance enhancement. The dimension of the model must thus be small, with difficulties in determining regional effects. The speed of convergence is also a concern here. Without an appropriate adjustment coefficient, convergence will be slow.

3.3. This paper's contribution

The purpose of this report is to evaluate the impact of regional FTAs on the Vietnamese agricultural and regional economies. With its long geographical shape, agricultural production varies from the north to the south. Together with proposed tariff reduction schedules for FTAs, gradually reducing over the next decade, our modelling task spans both time and region in Vietnam. In particular, in this report we make two major contributions:

- We build a full intertemporal version of the GTAP model for trade policy analysis. A dynamic GTAP model has been built by (Ianchovichina, 2012) using a recursive method, but this does not take into account intertemporal decisions. The recursive dynamic solution, therefore, does not represent a long-run optimal solution. Our intertemporal version of the GTAP model, instead, allows for optimising behaviour in the producer's problem over the long-run, taking investment decisions in advance, knowing that tariff reductions are coming soon and over time.

- Our second contribution is to improve the regional intertemporal CGE model for Vietnam, based on our previous works (Ha and Kompas, 2009; Ha et al., 2015). With a proper industry and commodity consolidation, we can calibrate the impact of multilateral FTAs on Vietnamese export quantities and import prices. They will serve as the feedback effect from Vietnam trading partners. We set them as exogenous shocks together with the reduction in tariffs to study the impact of FTAs on Vietnam. We would not be able to consider this feedback effect if we rely on a single country simulation alone. Additionally, in our single country set up, we will be able to expand our analysis to cover the impact of free trade reform to Vietnamese regional agricultural sectors, which will not be possible with an otherwise standard GTAP model.

4. intertemporal GTAP model and regional free trade agreements: The case of Vietnam

In this section, we build a fully intertemporal GTAP model (we call it GTAPINT) to examine the impact of a scheduled trade liberalisation on the Vietnamese economy. A major disadvantage of intertemporal models, as we learned from the above, is they are usually too big to solve. In order to overcome this problem, we will use our new parallel-processing solution method for intertemporal CGE models (Ha and Kompas, 2015). Ha and Kompas's 2015 method allows us to solve very large intertemporal CGE models efficiently with satisfactory regional and sectoral dis-aggregation.

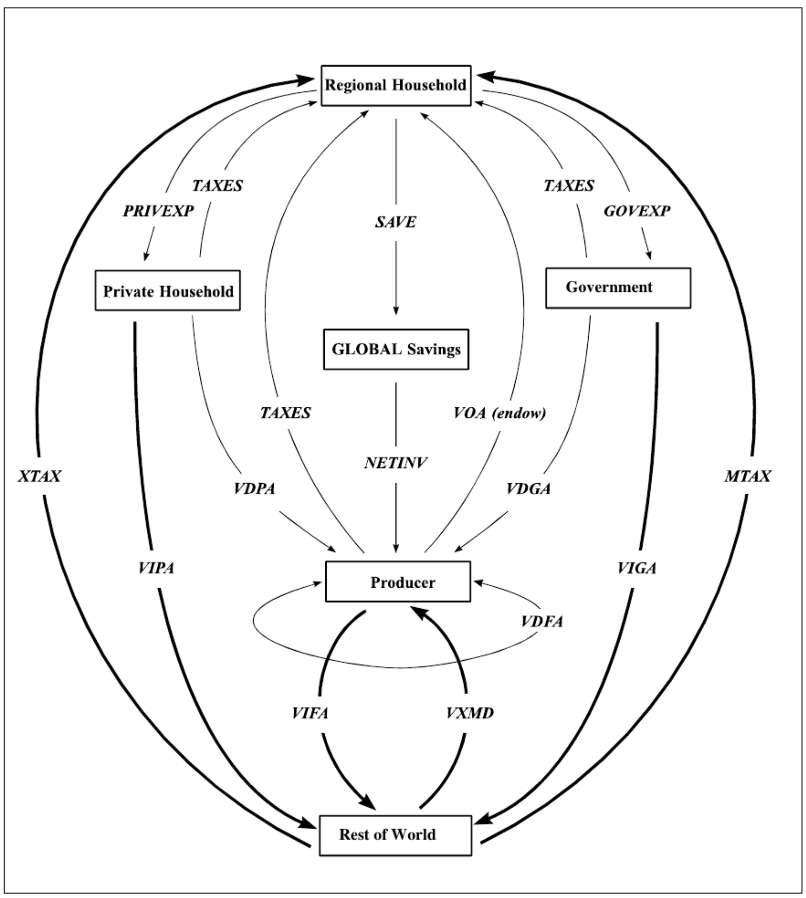
4.1. Overview of GTAP model and its current recursive solution approach

The GTAP model (Hertel, 1997) is a multi-regional model for the world economy. Fig 2 sketches the GTAP structure in a simple graphic. GTAP is a summation of single country models with an extensive multilateral trade matrix and global investment and transport activities. At its core, GTAP models a single country with an interacting regional consumer and producers. The regional consumer spends all of his or her income from the ownership of productive factors (i.e., labor, land, capital, natural resources) to either consume commodities or save in a nested demand structure [following Armington's 1969 separation assumption] with mixed Cobb-Douglas, Constant Difference Elasticity (CDE) and CES functions.

Regional households first allocate income to private and government consumption and saving, then with private consumption they allocate income to each commodity category. The next decision is to determine where to buy the commodities: domestically or through import. Imports, in turn, can be bought from anywhere in the world, with CES technology. Lastly, saving, is pooled together in a global bank and redistributed back to regions in the form of investment.

The regional producers also have a similar nested production structure: intermediate demands and primary production factor demands will be formed in steps. The producer first will decide how much each category of commodities (or factors) is required for their production, then where to buy them (domestically or through imports). Total investment in each region will be governed by the rental rate on capital of that region. Regional total investment add-ups to regional capital. Again, a nested demand structure is employed to determine the investment demand for each product and from where. Finally, the GTAP model also models a transportation service, which ships commodities between countries. The demand for transportation services is attached to international trade flows, while the supply is pooled from countries in a Cobb-Douglas setup.

Figure 2: Graphical representation of GTAP model.



source:Brockmeier (2001).

By its nature, the GTAP model is a static model. With the current set-up (version

6.2), GTAP relies on a short-run closure, where the capital stock (for the whole economy) at the beginning of a period is fixed and serves as the initial capital stock to calculate the end of period capital stock (additional net investment after subtracting depreciation). This end of period capital stock then serves as the beginning capital stock for the next period in a recursive sequence of simulations. (Ianchovichina, 2012) rely on this recursive sequence to build their dynamic GTAP model. The recursive dynamic model is clearly more informative than a static model, since it can be used to predict the growth path of the world economy, using a baseline scenario to compare growth paths under a policy change being investigated. The baseline scenario can be calibrated to resemble a credible external world growth forecasting model, or to resemble a past growth path, making the policy analysis more plausible. However, the recursive solution method has a serious drawback. It is not an intertemporal or optimal solution unless combined with a carefully designed rational expectations solution method. Both the built-in GTAP recursive setup (see Hertel, 1997) and the Ianchovichina (2012) dynamic recursive setup are adaptive, which means they rely on the past information to form agents' expectations. Without rational expectations, the solution for a prior period does not depend on future changes in policy, even though the change is currently known.

4.2. Our intertemporal GTAP model (GTAPINT)

In the current GTAP version (6.2), there is a single capital endowment for each country. It is mobile between sectors by size or by differentials on rental returns. Investment in every region will be defined by regional investors' expectations of the regional rate-of-return in the next period and the current period rate-of-return. Investors are assumed to behave in the way that regional rates-of-return are eventually equalised.

In our intertemporal GTAP model, we keep this single regional capital setup and change investment behaviour: investors now maximise long run investment returns according to:

$$\max_{QO(\text{“}CGDS\text{”},r,t)} \quad \int_0^\infty \Big\{ PS(\text{“}capital\text{”},r,t)QO(\text{“}capital\text{”},r,t) \tag{1}$$

$$-QO(\text{“}CGDS\text{”},r,t)PS(\text{“}CGDS\text{”},r,t)\Big\} e^{-RORG(t)t}dt$$

subject to:

$$\dot{QO}(\text{“}capital\text{”},r,t) = CAPINCR(r,t) - \delta(r)QO(\text{“}capital\text{”},r,t) \tag{2}$$

where $PS(\text{“}capital\text{”},r,t)$ is the rental price of region r capital at time t, $QO(\text{“}capital\text{”},r,t)$ is the regional capital stock at time t, $QO(\text{“}CGDS\text{”},r,t)$ is the total regional investment at time t, $PS(\text{“}CGDS\text{”},r,t)$ is the cost (price) of investment in region r at t, $\delta(r)$ is the regional depreciation rate, and $CAPINCR(r,t)$ is the increment in capital from investment activity. It is assumed that we need more than \$1 in investment $QO(\text{“}CGDS\text{”},r,t)$ to achieve a \$1 increase in capital:

$$QO(\text{“}CGDS\text{”},r,t) = CAPINCR(r,t)\left[1 + \frac{\phi(r)CAPINCR(r,t)}{2QO(\text{“}capital\text{”},r,t)}\right] \tag{3}$$

where $\phi(r)$ is a positive coefficient.

The Hamiltonian function is:

$$\mathcal{H} = PS(\text{“}capital\text{”},r,t)QO(\text{“}capital\text{”},r,t) \tag{4}$$

$$-QO(\text{“}CGDS\text{”},r,t)PS(\text{“}CGDS\text{”},r,t)$$

$$+\mu(r,t)[CAPINCR(r,t) - \delta(r)QO(\text{“}capital\text{”},r,t)] \tag{5}$$

with solution:

$$\begin{aligned}
\mu(r,t) &= \frac{\partial QO(\text{“}CGDS\text{”},r,t)}{\partial CAPINCR(r,t)} PS(\text{“}CGDS\text{”},r,t) \\
&= \left[1+\phi(r)\frac{CAPINCR(r,t)}{QO(\text{“}capital\text{”},r,t)}\right] PS(\text{“}CGDS\text{”},r,t) \qquad (6)
\end{aligned}$$

$$\dot{QO}(\text{“}capital\text{”},r,t) = CAPINCR(r,t) - \delta(r)QO(\text{“}capital\text{”},r,t) \qquad (7)$$

$$\begin{aligned}
\dot{\mu}(r,t) &= \mu(r,t)[RORG(t)+\delta(r)] + \frac{\partial QO(\text{“}CGDS\text{”},r,t)}{\partial QO(\text{“}capital\text{”},r,t)} PS(\text{“}CGDS\text{”},r,t) \\
&\quad - PS(\text{“}capital\text{”},r,t) \\
\dot{\mu}(r,t) &= \mu(r,t)[RORG(t)+\delta(r)] - \frac{\phi(r)}{2}\left(\frac{CAPINCR(r,t)}{QO(\text{“}capital\text{”},r,t)}\right)^2 PS(\text{“}CGDS\text{”},r,t) \\
&\quad - PS(\text{“}capital\text{”},r,t) \qquad (8)
\end{aligned}$$

4.3. Steady state and base line scenarios

The above solutions need two additional terminal conditions. For numerical feasibility, we assume that at some terminal time T (large), capital and its shadow price μ will remain constant:

$$\begin{aligned}
QO(\text{“}capital\text{”},r,T) &= CAPINCR(r,T)/\delta(r) \qquad (9) \\
PS(\text{“}capital\text{”},r,T) &= \mu(r,T)[RORG(T)+\delta(r)] \qquad (10) \\
&\quad -\frac{\phi(r)}{2}\left(\frac{CAPINCR(r,t)}{QO(\text{“}capital\text{”},r,t)}\right)^2 PS(\text{“}CGDS\text{”},r,T)
\end{aligned}$$

We use the baseline scenario as calibrated at the steady state. In fact, the capital stock, its rental and shadow price will be calibrate to satisfied Equations 9 and 10. By doing so, we can effectively convert the current world economy into a steady state system. The approach is adequate since we are only concerned with the difference between the baseline scenario and a 'policy shock' (with FTAs) scenario (Dixon et al., 1992). Note, however that the baseline scenario need not to be at the steady state all the time. We can predict the growth path of the world economy in the short and long run and use the path to calibrate the baseline scenario as well. This, however, will require extensive data collection and predictive effort, which goes well beyond the scope of our report. We thus leave it as a future research direction.

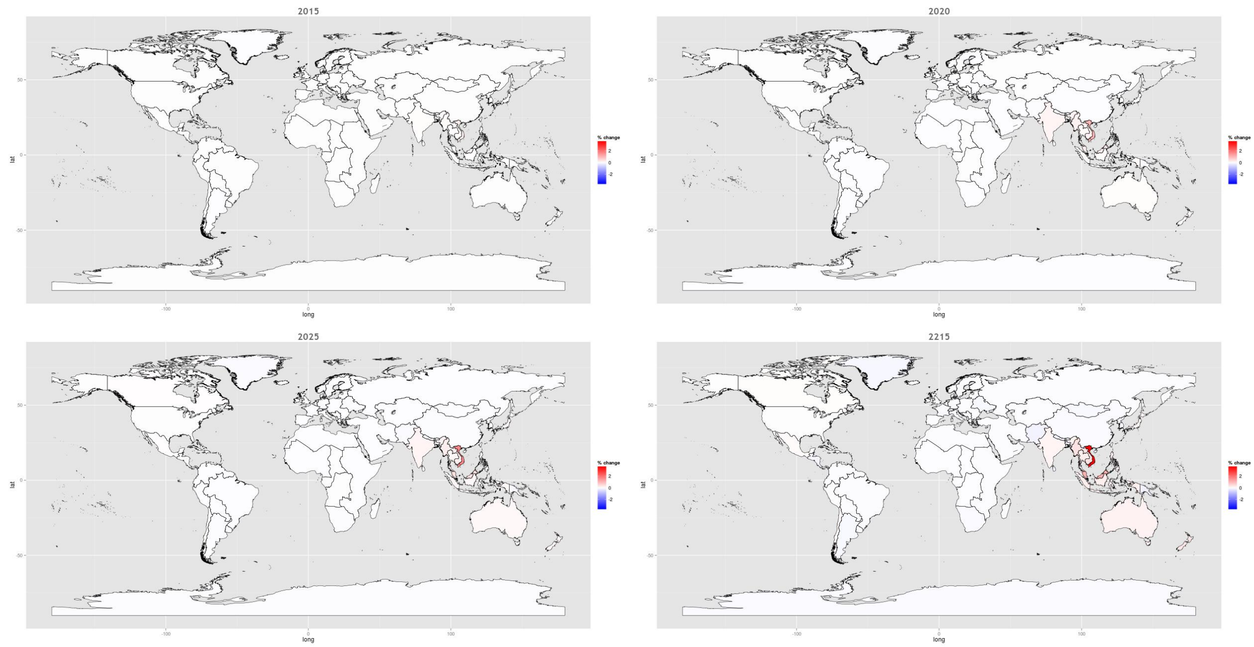
4.4. Modelling regional FTAs

Tariff reduction schedules are available in the form of legal documents, but are very difficult to use (Petri et al., 2012). Even worse, the is no published tariff reduction schedule for the TPP since the deal is awaiting approval from member countries' parliaments. Therefore, we follow Petri et al. (2012) and use a linear approximation approach to build bilateral tariff reduction schedules between 18 regions and countries under the above seven regional FTAs. As we aim to simulate a free trade outcome, we assume the prior bilateral free trade agreements will dominate the later regional FTA. For example: tariff reduction schedules between Vietnam and Australia are based on AANZFTA, and less so on future TPP changes, unless the TPP schedule is faster. We also follow Petri et al. (2012) by assuming some utilisation rate (FTAs are usually under-utilised) and a maximum reduction rate, which are, approximately, 0.62 and 0.92 respectively.

4.5. Simulation results

Given its market size and current tariff reduction schedule (most of the current FTAs are finishing), the TPP is expected to have a new round of effects on Vietnamese economy, over the next decade. Results and Figure 3 clearly shows Vietnam as the 'biggest winner' among its trading partners under the current FTAs, including the TPP and EU-Vietnam FTA. Vietnam's GDP can increase from 0.2 to 0.91% in the next five years, much higher than the 0 to 0.2% growth rate of the second largest benficary, Malaysia. In the long run, Vietnam's GDP can increase by 3.67%, while Malaysia gains only 1.13%. Note that, in our analysis, we study the tariff reduction schedule only. The gain is expected to increase when the reduction of non-tariff trade barriers can be quantified and included in the analysis.

Figure 3: Impact on the world economy.



Source: Author's calculation.

Focusing more closely on the Vietnamese economy, we can pick the industries with the largest net gains (see Table 2): textiles and its supplier, plant-based fibres. Construction also gains due to economic expansion, as does the transportation sector.

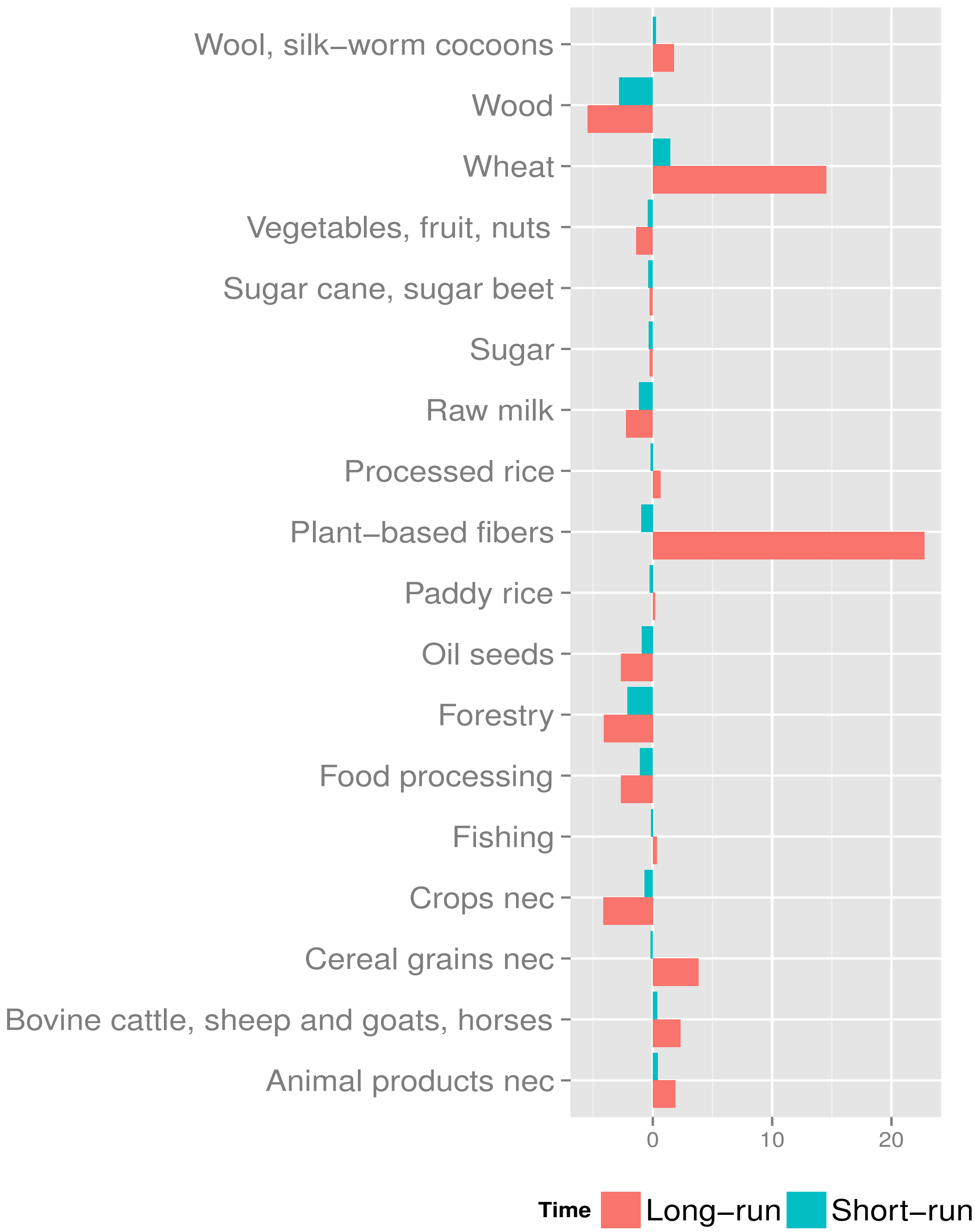
Table 2: Biggest winners and losers (% increase in production output.)

	2015	2016	2017	2018	2019	2020	2025	2215
Textiles	-1.01	0.36	2.23	4.79	6.18	7.61	15.05	34.26
Plant-based fibers	-0.98	-0.03	1.26	3.02	3.94	4.94	10.01	22.76
Wheat	1.45	3.60	5.92	8.49	9.17	9.85	10.85	14.54
Construction	6.17	6.63	7.05	7.38	7.45	7.53	7.77	7.06
Transport	1.64	2.20	2.78	3.36	3.47	3.57	4.03	5.00
Food processing	-1.06	-1.20	-1.36	-1.62	-1.69	-1.76	-2.11	-2.66
Transport Equipment	0.41	0.02	-0.52	-1.22	-1.43	-1.58	-2.58	-3.16
Forestry	-2.12	-2.32	-2.65	-3.11	-3.23	-3.33	-4.07	-4.12
Crops nec	-0.70	-0.74	-0.82	-0.95	-0.99	-1.16	-2.12	-4.16
Wood	-2.83	-3.09	-3.49	-4.07	-4.23	-4.37	-5.31	-5.47

Source: Authors' calculation.

However, there are five net losers in terms of output, all are in agriculture or agricultural related industries. Food processing and wood and forestry are the most severely shrinking sectors. Other agricultural crops are adversely affected too. Looking at agriculture generally we can see a mixed picture for the Vietnamese agricultural sector under current FTAs: some sectors gain and some lose (see Figure 4). Besides textile related commodities, positive gains accrue for the following agricultural commodities (mostly in the long-run): wheat; cereal grains; bovine cattle, sheep and goats, horses; animal products and wool, silkworm cocoons. Decreases in output occur for vegetables, fruits, nuts; raw milk; oil seeds; forestry and other crops.

Figure 4: Impact on agricultural output (growth, %).



Source: Authors' calculation.

The impact on agricultural sectors is perhaps more worrisome if we look at the predictions for export performance. Although export prices are higher for most of Vietnam's agricultural exports, export quantities fall for most, especially in the long run. Furthermore, the reduction in export volume generally outweighs the increase in prices, so that total export revenue falls. Vietnam will thus face vigorous competition for agricultural products under the current FTAs.

Table 3: Impact on quantity and price of agricultural exports.

	Export volume				Export price			
	2015	2020	2025	2215	2015	2020	2025	2215
Paddy rice	-2.51	-7.20	-11.01	-18.76	0.36	1.07	1.58	2.58
Wheat	2.89	15.39	16.09	19.29	-0.05	-0.43	-0.55	-0.70
Cereal grains nec	-0.74	-2.81	-4.77	-9.22	0.35	1.39	2.23	4.14
Vegetables, fruit, nuts	-0.71	-2.29	-3.61	-6.45	0.25	0.89	1.34	2.30
Oil seeds	0.37	1.98	1.30	-0.87	-0.08	-0.34	-0.20	0.31
Sugar cane, sugar beet	-1.63	-5.25	-8.12	-14.00	0.28	0.95	1.51	2.77
Plant-based fibers	-0.19	-4.21	-7.33	-14.34	0.00	1.07	1.96	4.11
Crops nec	-0.65	-1.03	-2.03	-4.24	0.16	0.65	0.79	1.04
Bovine cattle, sheep and goats, horses	-1.77	-4.09	-6.19	-10.51	0.44	1.02	1.56	2.73
Animal products nec	-0.79	-1.29	-1.88	-3.12	0.30	0.51	0.83	1.54
Raw milk	-2.56	-2.97	-4.25	-6.55	0.31	0.26	0.44	0.78
Wool, silk-worm cocoons	-2.67	-3.62	-6.61	-12.85	0.21	0.32	0.55	1.07
Forestry	-1.03	-1.22	-2.43	-4.37	0.34	0.80	1.07	1.54
Fishing	-1.23	-1.63	-2.68	-4.30	0.63	1.05	1.61	2.53
Processed rice	-1.25	-1.22	-1.26	-1.23	0.45	1.04	1.50	2.31
Sugar	-3.12	-3.67	-2.07	-2.07	0.57	0.95	1.31	1.73
Food processing	-1.95	-1.10	-1.51	-3.35	0.46	0.54	0.76	1.04
Wood	-3.02	-4.44	-5.42	-5.64	0.54	0.83	1.04	1.14

Source: Authors' calculation.

Another interesting point to note is in the comparison of export performance with domestic production. Although the domestic production of bovine cattle, sheep and goats, horses and animal products all increase (moderately) under the current FTAs, their export volumes fall considerably, especially for bovine cattle, sheep and goats, and horses. This shows that any gain in the production of these commodities is purely largely to domestic economic expansion, and not because of their international competitiveness. In fact, these sectors are losing in the international market.

5. Impacts of regional trade agreements on the Vietnamese agricultural sector and rural areas

The GTAP model is, generally, the best model for trade impact analysis. By modelling the whole world economy, it allows us to analyse the interaction between countries in the way that is otherwise impossible for a single country model. Nevertheless, by modelling the whole world, a GTAP model has to be simple and dimensionally constrained. In the case of Vietnam, a standard GTAP model omits regional aspects, which is important for agricultural and rural development analysis. In this section, we will focus on building an intertemporal regional CGE model and its database for Vietnam. To close the gap between both GTAP and single country models, we will connect the results from the GTAPINT model to the Vietnamese CGE model. In other words, export and import prices and quantity shocks due to the FTAs will be imported from the GTAPINT model to the Vietnamese CGE model. By doing so, we can employ both models to address the specific challenges under investigation in this report.

5.1. Vietnamese regional intertemporal CGE model

Our model was developed from a single country ORANI-G model (Dixon et al., 1982; Horridge, 2003). ORANI-G is a single country CGE model with a final demand side formed by household, government, investors, the rest of the world and inventories, and a supply side formed by a producer in every industry. With the exception of export and inventories demand, which depend on a downward sloping demand curve in the case of export demand (or ROW) or tied with commodity flows (from producer to consumer) in the case of inventories demand, the household, government and investment demands are formed by a tree-like structure with a mix of Linear Expenditure and CES functions.[1] Meanwhile, producers provide final products by combining intermediate commodities and production factors also in a tree like (or nested) structure with a combination of Leontief and CES production functions. The output from production will be sold to domestic and ROW destinations by employing a Constant Elasticity of Transformation technology. The margins (trade, transportation costs) and taxes will be added to the final product before reaching consumers. Household and government income are formed from factor of production income and taxes.

The first regional extension of the ORANI model for Vietnam was built to evaluate the impact of rice export policy on Vietnamese households (Ha et al., 2015). The extension was accomplished by adding a regional extension to the model, basically treating each region as a separate but interacting economy. To that extent, the Vietnamese regional CGE model will resemble a GTAP model with multiple independent but interacting economies as regions (without the ROW of course). In the Vietnamese model, the commodities will be exported to both regions in the country and the rest of the world.

An intertemporal extension of the model was first built into the Vietnamese model by Ha and Kompas (2009). In this section, we improve on Ha and Kompas's 2009 model by assuming regional government debt. Other than that, we keep the intertemporal extension of Ha and Kompas (2009) unaltered and document it here for easy reading.

There are three major differences between static and dynamic (intertemporal) versions of the Vietnamese CGE model: the long term producer's and consumer's problem and financial equations.

[1]We replace the LES top level of household demand structure of ORANI model to the similar LES structure from MONASH model Dixon and Rimmer (2002) to inherit parameter values from VIPAG Giesecke and Tran (2008).

5.1.1. Producer's problem

Unlike a static ORANI model, the producer in an intertemporal model can choose the level of the capital stock to maximise profit in the long run. We base our system on ORANI's production structure and assume a Leontief production function with a fixed proportion between intermediate composite goods and a primary factor composite input. The producer maximises long run profit by choosing the capital level and other factors to form a primary factor composite with CES technology, or:

$$\begin{aligned} X1PRIM(rit) \;=\; & \Bigg(DELTA1CAP(rit)\left[\frac{X1CAP(rit)}{A1CAP(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}} \\ & +DELTA1LAB(rit)\left[\frac{X1LAB\_O(rit)}{A1LAB\_O(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}} \\ & +DELTA1LND(rit) \\ & \left[\frac{X1LND(rit)}{A1LND(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}}\Bigg)^{\frac{SIGMA1PRIM(rit)}{SIGMA1PRIM(rit)-1}} \end{aligned} \tag{11}$$

where r, i, t are indices for region, industry and time; $X1PRIM$ is the composite of primary factors; $X1CAP, X1LAB\_O, X1LND$ are production factors for capital, labour and land respectively; $DELTA1CAP$ is a coefficient; $A1CAP, A1LAB\_O, A1LND$ are technological progress variables attached to capital, labour and land; and $SIGMA1PRIM$ is the elasticity of substitution.

The long run problem of the producer is thus to choose investment ($X1INV$), labour ($X1LAB$), and land ($X1LND$) to maximise returns or dividends DIV:

$$\max_{X1INV(rit),X1LAB(rit),X1LND(rit)} \int_s^{\infty} DIV(rit)e^{-\int_t^s IRATE(v)dv}dt \tag{12}$$

where $IRATE$ is the interest rate. The dividend by itself is income from capital, which is net factor income after deductions for other factor incomes (i.e., labour and land):

$$
\begin{aligned}
DIV(rit) = \; & \big[P1PRIM(rit)X1PRIM(rit) \\
& -P1LAB\_O(rit)X1LAB\_O(rit) \\
& -P1LND(rit)X1LND(rit)\big] - P2TOT(rit)X2TOT(rit)
\end{aligned} \tag{13}
$$

where $P1PRIM, P1LAB\_O, P1LND, P2TOT$ are the price of the primary factor composite of labour, land and investment goods; and $X2TOT$ is the total investment in goods needed to achieve $X1INV$ the increment in capital, so that:

$$
X2TOT(rit) = \left(1 + \frac{CPHI(rit)X1INV(rit)}{2X1CAP(rit)}\right) X1INV(rit) \tag{14}
$$

The maximisation problem for Eq. 12 is subject to a capital motion constraint:

$$
X1\dot{C}AP(rit) = X1INV(rit) - KAPPA(rit)X1CAP(rit) \tag{15}
$$

where $KAPPA$ is a depreciation coefficient. The solution for the long term producer problem is thus:

$$P1LAB\_O(rit) = P1PRIM(rit) A1LAB\_O(rit)^{-1} DELTA1LAB(rit) \left[\frac{X1PRIM(rit) A1LAB\_O(rit)}{X1LAB\_O(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} \tag{16a}$$

$$P1LND(rit) = P1PRIM(rit) A1LND(rit)^{-1} DELTA1LND(rit) \left[\frac{X1PRIM(rit) A1LND(rit)}{X1LND(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} \tag{16b}$$

$$MU(rit) = P2TOT(rit)[1 + \frac{CPHI(rit) X1INV(rit)}{X1CAP(rit)}] \tag{16c}$$

$$\dot{MU}(rit) = IRATE(t) MU(rit) - \frac{CPHI(rit)}{2} \left(\frac{X2INV(rit)}{X1CAP(rit)}\right)^2 P2TOT(rit) - P1PRIM(rit) A1CAP(rit)^{-1} DELTA1CAP(rit) \left[\frac{X1PRIM(rit) A1CAP(rit)}{X1CAP(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} + MU(rit) KAPPA(rit) \tag{16d}$$

$$X1\dot{CAP}(rit) = X1INV(rit) - KAPPA(rit) X1CAP(rit) \tag{16e}$$

where MU is the shadow price of capital.

Finally, to facilitate the integration of the intertemporal module into the ORANI model, we calculate the instantaneous average rental price of capital:

$$
\begin{aligned}
P1CAP(r,i,t) &= \Big[P1PRIM(rit)X1PRIM(rit) \\
&\quad -P1LAB\_O(rit)X1LAB\_O(rit) \\
&\quad -P1LND(rit)X1LND(rit)\Big]/X1CAP(r,i,t) \\
&= \big[P1PRIM(rit)X1PRIM(rit) \\
&\quad -P1PRIM(rit)A1LAB\_O(rit)^{-1}DELTA1LAB(rit) \\
&\quad \left[\frac{X1PRIM(rit)A1LAB\_O(rit)}{X1LAB\_O(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} \\
&\quad X1LAB\_O(rit) \\
&\quad -P1PRIM(rit)A1LND(rit)^{-1}DELTA1LND(rit) \\
&\quad \left[\frac{X1PRIM(rit)A1LND(rit)}{X1LND(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} \\
&\quad X1LND(rit)\Bigg]/X1CAP(r,i,t) \\
&= P1PRIM(rit)X1PRIM(rit)^{\frac{1}{SIGMA1PRIM(rit)}} \\
&\quad \Bigg\{X1PRIM(rit)^{\frac{SIGMA1PRIM(rit)}{SIGMA1PRIM(rit)-1}} \\
&\quad -DELTA1LAB(rit) \\
&\quad \left[\frac{X1LAB\_O(rit)}{A1LAB\_O(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}} \\
&\quad -DELTA1LND(rit) \\
&\quad \left[\frac{X1LND(rit)}{A1LND(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}}\Bigg\}/X1CAP(r,i,t) \\
&= P1PRIM(rit)X1PRIM(rit)^{\frac{1}{SIGMA1PRIM(rit)}} \\
&\quad DELTA1CAP(rit)\left[\frac{X1CAP(rit)}{A1CAP(rit)}\right]^{\frac{SIGMA1PRIM(rit)-1}{SIGMA1PRIM(rit)}} \\
&\quad /X1CAP(r,i,t) \\
&= P1PRIM(rit)A1CAP(rit)^{-1}DELTA1CAP(rit) \\
&\quad \left[\frac{X1PRIM(rit)A1CAP(rit)}{X1CAP(rit)}\right]^{\frac{1}{SIGMA1PRIM(rit)}} \qquad (17)
\end{aligned}
$$

The formula is identical to the static version of the capital price in an ORANI model. Therefore, the inclusion of the intertemporal module does not break the intra-period primary factor demand structure in an ORANI model. Furthermore, we can place the above average price of capital into the motion equation 18 and simplify it to obtain:

$$\begin{aligned} \dot{MU}(rit) &= IRATE(t)MU(rit) - \frac{CPHI(rit)}{2}\left(\frac{X2INV(rit)}{X1CAP(rit)}\right)^2 P2TOT(rit) \\ &\quad -P1CAP(rit) + MU(rit)KAPPA(rit) \end{aligned} \tag{18}$$

For completeness, we specify two terminal conditions: the first condition is simply to treat the initial capital level as exogenous and the second condition is that the shadow price of capital should remain constant at a steady state:

$$\begin{aligned} MU(rit)(IRATE(t) + KAPPA(rit)) &= \frac{CPHI(rit)}{2}\left(\frac{X2INV(rit)}{X1CAP(rit)}\right)^2 P2TOT(rit) \\ &\quad +P1CAP(rit) \end{aligned} \tag{19}$$

5.1.2. Consumer problem

Consumers also maximise utility over the long run, or:

$$\max_{X3TOT(r,h,t)} \int_s^\infty ln[X3TOT(r,h,t)]e^{-THETAt}dt \tag{20}$$

subject to a debt constraint:

$$\begin{aligned} \dot{DEBT}(r,t) &= [V0CIF\_C(r,t) - V4TOT(r,t)]/PHI(t) \\ &\quad +IRATESTR(t)DEBT(r,t) \end{aligned} \tag{21}$$

where h is the household index; $X3TOT$ is the private household consumption; $THETA$ is a discount rate; $V0CIF\_C$ and $V4TOT$ are the total regional imports and exports; and PHI is the exchange rate.

The solution of the household problem will be a system defined by Equation 21 and the following equations:

$$PHI(t) = X3TOT(r,h,t)P3TOT(r,h,t)LAMBDA(r,h,t) \tag{22a}$$

$$L\dot{AMBDA}(r,h,t) = [THETA(t) - IRATESTR(t)]LAMBDA(r,h,t) \tag{22b}$$

with terminal conditions:

$$D\dot{E}BT(T) = 0 \tag{23a}$$

$$LA\dot{M}BDA(r,h,T) = 0$$

where $LAMBDA$ is the shadow price of the regional debt level. To facilitate model interpretation, we also define a national debt level $NDEBT$ as the sum of all regional debt levels:

$$NDEBT(t) = \sum_r DEBT(r,t) \tag{24}$$

In order to facilitate monetary policy simulation, we define a money demand equation and 'uncovered interest rate parity' equations:

$$MSUPPLY(t) = IRATE(t)^{\eta}\left[\sum_{c,r,i,t} P0COM(c,r,t) * Q1(c,r,i,t)\right] \tag{25}$$

$$IRATE(t) = IRATESTR(t) + \frac{P\dot{H}I(t)}{PHI(t)} \tag{26}$$

where c is the commodity index; $MSUPPLY$ is the money supply; $P0COM$ and $Q1$ are the aggregate price level and production; and $IRATESTR$ is the international interest rate. At the steady state, the domestic interest rate must be equal to international interest rate (Blanchard and Fischer, 1989, page 45):

$$IRATE(T) = THETA(T) = IRATESTR(T) \tag{27}$$

5.2. Data compilation

The first database for an Vietnamese intertemporal regional CGE model was been built by Thang et al. (2011). With the release of the official IO table from the General Statistic Office for the year 2007 (General Statistical Office, 2010*b*), we decided to build an improved database based on the official version of the IO table. With the IO data, the database, first, has been built for a single country model, then the single country database has been converted to a regional database for the year 2007 using ratios from the regional database in 2005 (Ha et al., 2015). The intertemporal database has been built by assuming the current period (or 2007) is at the steady state and its capital stock and shadow price have been calibrated accordingly. We also recalculate the new margin and investment matrices, which are based on well known theoretical foundations.

Database structure overview and input-output tables

To be able to do a simulation with an ORANI style model, we need to convert Input-Output data into a form readable by the ORANI database. We thus follow Horridge (2003) and convert the Vietnamese Input-Output database into a ORANI style database. The latest publicly available Vietnamese Input-Output data is for the year 2007 (General Statistical Office, 2010*b*). The reported Vietnamese Input-Output tables are in three forms: (1) at final users' price; (2) at producers' price; and (3) at a basic price. The three are different in terms of margins and taxes. However, we found that the final user price and producer price tables are the same, only different in reporting form. Hence, we use only the basic price and final user price tables in our calculations.

The final user price Input-Output table (Figure 5) has a typical rotated L-shape, which represents consumption and production sides. On the consumption side, the Input-Output table includes intermediate, household, government, investment (both in fixed capital and inventories), and export demand. The import component of the demands will be subtracted at the end of the row to derive the total consumption of domestic commodities.

On the production side, intermediate demand is summed-up vertically with compensation to labour, capital (both in terms of profit or surpluses and depreciation) and taxes used to

Figure 5: Final user price Input-Output table.

								Minus	
		Industries	Household	Government	Investment	Inventories	Export	Import	Duties
	Size	I	1	1	1	1	1	1	1
Commodities	C	X	X	X	X	X	X	X	X
Labor	1	X							
Operating surplus	1	X							
Depreciation	1	X							
Production Tax	1	X							
Commodity Tax	1	X							

I = Number of industries (138)

C = Number of commodities (138)

X = Matrices have values

Source: Constructed from General Statistical Office's 2010*b* data.

derive the total production of domestic products (or commodities). The total production of domestic commodities (or column total) must be equal to the total consumption of the domestic commodities (row total, as the above).

The basic price Input-Output table (Figure 6) is different to the final user price Input-Output table only in terms of imports (and import duties) and commodity taxes. The final consumption matrices (intermediate, household, government, investment, and exports) in the basic price Input-Output table are net of imports and taxes. All imports and duties are summed-up at the Import+Tax row. The commodity tax has been provided only for the final use items (not for intermediates). The sum of the commodity tax row in the basic price Input-Output table is equal to the sum of the commodity tax row in final user price table.

In order to be able to do a simulation with an ORANI style model, the Input-Output tables also need to be converted into an ORANI style database (see Figure 7). The data base resembles the above Input-Output tables in the sense that it also has a rotated L-shape with the rows to represent final consumption or use (BAS1-BAS6), columns that represent domestic production with intermediate use, and the use of production factors (BAS1, V1LAB, V1CAP, V1LND, V1PTX). The two major differences between Input-Output ta-

Figure 6: Basic price Input-Output table.

	Size	Industries	Household	Government	Investment	Inventories	Export
	Size	I	1	1	1	1	1
Commodities	C	X	X	X	X	X	X
Import+Tax	1	X	X	X	X	X	
Commodities Tax	1		X	X	X	X	X
Labor	1	X					
Operating surplus	1	X					
Depreciation	1	X					
Production Tax	1	X					

I = Number of industries (138)

C = Number of commodities (138)

X = Matrices have values

Source: Constructed from General Statistical Office's 2010*b* data.

bles are that imports has been decomposed from the final consumption matrices, with the matrices BAS1-BAS6 having an extra source dimension (domestic or imports). There is also information on margins and taxes, which correspond to every single element in the final use matrices. The margins and tax matrices are not available in Input-Output tables and need to be constructed.

5.2.1. Database construction

As we can see from the above, information in the Vietnamese Input-Output tables that can be included in the ORANI database without much effort. For other data, external information is needed for calibration. Care should be taken to ensure both the market clearing condition for domestically produced commodities and an equality between GDP by income and expenditure methods. In the section, we present the database construction, step-by-step, in logical order.

Final consumption

First, we construct the basic intermediate matrices. Our database is constructed for the whole country, hence, the set, or Source (S), consists of only two elements: domestic and imported goods. The basic intermediate matrices are, therefore, constructed for intermediate demand that are domestically produced or imported. Both matrices will have 138 rows (or 138 commodities, denoted by the set C) and 138 columns (or 138 industries, denoted by the set I). In other words, the basic intermediate demand matrix (BAS1) will have three dimensions: CxSxI.

Figure 7: Overview of the database structure.

		Industries	Investors	Household	Export	Government	Inventories
	Size	I	I	1	1	1	1
Basic Flows	CxS	BAS1	BAS2	BAS3	BAS4	BAS5	BAS6
Margins	CxSxM	MAR1	MAR2	MAR3	MAR4	MAR5	
Taxes	CxSxT	TAX1	TAX2	TAX3	TAX4	TAX5	
Labor	1	V1LAB					
Capital	1	V1CAP					
Land	1	V1LND					
Production Tax	1	V1PTX					

I = Number of industries (138)
C = Number of commodities (138)
S = Sources (2)
M = Number of margin commodities (5)

	Joint production matrix
Size	I
C	MAKE

	Import duties
Size	1
C	V0TAR

Source: Constructed following the ORANI Horridge (2003) database style.

The domestic basic intermediate demand matrix is essentially the intermediate matrix from the basic price Input-Output table. The construction of the import intermediate demand matrix is a bit more tricky. First of all, we note that in the Vietnamese Input-Output tables commodity taxes are reported only for final demand items: the sum of commodity tax for final demand items equals the sum of all commodity taxes. Therefore, the imported intermediate demand can be constructed by subtracting the intermediate demand matrix in the final user price table and the basic price table.

The final demand matrices for investment, household, exports, government and inventories (BAS2-BAS6) can also be constructed similarly as the basic intermediate demand matrix. The domestic component of BAS2-BAS6 are readily available from the basic price Input-Output table. The import component of BAS2-BAS6 are not available in Input-Output tables, therefore we assume the ratio of each import final demand (BAS2-BAS6) is the same as the share of imports in total domestic final demand. The import final demand for investment, household, exports, government and inventories then can be calculated by multiplying the corresponding domestic demands with this ratio.

For investment demand, the above matrix subtraction can only be calibrated to the total investment demand (both domestic and imported) of all industries. Unfortunately, the information to decompose the vector of final investment demand into industry investment demand is not available in Input-Output tables. We need to use external information to decompose the vector. To do that, first we note:

$$K_{i,t+1} - K_{i,t} = I_{i,t} - D_{i,t} \tag{28}$$

where $K_{i,t}, I_{i,t}, D_{i,t}$ are the capital stock, investment demand and depreciation of industry i at time t. Knowing $K_{i,t}$, $K_{i,t+1}$ and $D_{i,t}$ allows us to calculate $I_{i,t}$.

The capital stock and capital growth rate for each industry needs to be calibrated. The capital stock at the end of 2006 and 2007 can be proxied by the fixed asset and long-term investment statistics provided by the General Statistical Office of Vietnam, which are summarised from its Enterprise Surveys (General Statistical Office, 2010*a*). The survey data is available only for 56 industries, summarised from the Vietnam standard industrial classification (VSIC). There are two VSIC versions: the 1993 version (The Government, 1993; General Statistical Office, 1993) and the 2007 version (The Prime Minister, 2007; Ministry of Planning and Investment, 2007). We convert the above 56 industries into 138 industries using knowledge of both VSIC tables and their corresponding table (General Statistical Office, n.d.). To avoid confusion, we first shrink the 56 and 138 industry codes down to 52 common industries. The capital stocks for merging industries (from 56 to 52 industries) will be summed-up.The 52 industries data then will be expanded to 138 industries. We assume common rates of return for those industries that have common 52 industry codes. With this assumption, we can effectively decompose the capital stocks for 52 industries into the smaller 138 industries dataset, proportionally with the operating surpluses given in Input-Output tables.

The newly adjusted proxy capital stock together with depreciation data (also from Input-Output tables) will serve as input for calculation of the proxy for investment demand as in Equation 28. Before that, depreciation data will be adjusted to make sure that the overall depreciation rate for the whole economy will be 6.5% following (Giesecke and Tran, 2008).

Finally, the calculated investment demand will serve as a proxy for industry investment demand. We will use it to calculate the share of individual industry investment demand (in 138 industries) and overall 138 industries' investment demand. Using the shares, the domestic and imported investment demand can be effectively decomposed into 138 by 138 investment demand matrices.

Production

On the production side, the intermediate demand (1BAS) and income and tax matrices need to be constructed. Labour income and production taxes are directly available from the Input-Output tables. The capital income (V1CAP) will be a sum of operating surpluses and depreciation. The income for land (V1LND) is not available from the Input-Output tables, so we set the elements of the matrix to zero and ignore this land factor in our simulation.

Production taxes

With the calculated domestic and import demand matrices, the commodity taxes can be easily calculated by subtracting them from the corresponding demand items in final user price Input-Output table. The matrix then will be decomposed into commodity taxes for domestic and imported matrices using the domestic and import shares in total consumption (or equivalently assuming the same tax rate for domestic and imported goods). Note, however, that the (transposed) sum of commodity tax by row should be equal to the commodity tax row in the final user price Input-Output table. Incidentally, the two rows are roughly equal (with some small rounding errors only). This saves us from using other techniques to equalise the total domestic supply and its use.

Margins

The Input-Output tables provide no information for margins. We need to construct the margins using other external information sources. First, we define five margin commodities: trade, road transportation, rail transportation, air transportation and water transportation. Second, we follow Giesecke and Tran (2008) and assume a constant share of margin's use by users (intermediate, household, government, investor, and exports). This means, for example, a fixed share of domestic and imported intermediate demand will be used for margin purposes. Similarly for other demands (with the exception of inventory demand where we do not calculate margin for inventories), fixed shares are calculated from Chinese data (Centre of Policy Studies, n.d.) – data similar to the Vietnamese economy. With the calculated fixed share, a vector of margin use can be calculated for each user and for both their domestic and import demands. Finally, the vector of margin use can be decomposed into full margin matrices (MAR1-MAR6) following Eurostat's (2008) method. In particular, the relevant margin commodities will be defined first (in our case, the commodities with ID from 1 to 86). The margin related to each of the above related commodities will then be calculated proportionally to the share of final use related commodities.

5.2.2. The make matrix and tariffs

The Input-Output tables provide no information on the joint production matrix. We, therefore, assume a diagonal make matrix with the diagonal equal to the total production and use of the domestically produced commodities. The duty or tariff vector is taken directly from the final user price Input-Output table.

5.2.3. Parameters and Elasticities

The parameters and elasticities that need to be defined are the elasticity of substitution between primary factors; substitution elasticities between domestic and foreign sources of supply; the export demand elasticities; the Armington elasticity for intermediate, household and investment categories; household expenditure elasticities, and the FRISCH parameter. All the parameters and elasticities needed for the Vietnamese ORANI model are available from Giesecke and Tran (2008). We convert the parameter for 112 commodities (as in Giesecke and Tran, 2008) to 138 commodities using the corresponding table from (General Statistical Office, 2010*b*). Care also has been taken to ensure that the product of income elasticity with its budget share equals one.

Another parameter that needs to be defined is the individual or collective export commodities indicator. Export demand in the ORANI model is divided between individual and collective exports. The difference is how international demand relates to export price changes (Horridge, 2003). We have no information on any group of export commodities in which export demand is related to their average export price, hence we assume all commodities are individual.

5.2.4. Rounding Errors

At the final step, we check the database for market clearing conditions for domestic commodities and GDP equality. We discover that the rounding errors (Input-Output tables are reported in round numbers) has created a small gap between total supply and demand for domestic products. To minimise the distortion in our data (compared with the original Input-Output tables data) we add the errors to V1LAB, a relatively large item among income matrices. The maximum absolute change (error) in V1LAB in this case is 0.15%.

5.3. Regional FTAs simulation

With the results from GTAP model simulation readily available, we can use its output to introduce shocks to the Vietnamese model to access the impact of regional FTAs to agriculture and the rural sector in Vietnam. In particular, we identified three most important shocks: tariff reduction, change in import prices and change in the country's exports. We also design the best common sectors and commodities classification to minimise the discrepancy in prediction between the two models.

5.3.1. Tariff shock

Unlike the GTAP model, in the Vietnamese CGE model we do not identify trade flows to every trading partner, instead the rest of the world has been modelled as a single sector, as import demand. In order to mimic the tariff reduction in the GTAP model, we calculate an average tariff reduction of Vietnam for its trading partners. The trade volume has been used as weights to provide more accurate estimates of Vietnamese tariff barrier reductions in the coming years.

5.3.2. Import price shock

In the Vietnamese CGE model, the import (CIF) price is an exogenous variable. The producer and household will choose the quantity of imports according to the price ratio between imported and substitutable domestically produced commodities. Similar to the case of above tariff shock, the Vietnamese CGE model does not identify specific sources of importation. Instead, imports are modelled as an single import from the rest of the world. Fig 8 shows a moderate import price impact to the Vietnamese economy. The price increase in the long run is much more significant than in the short-run.

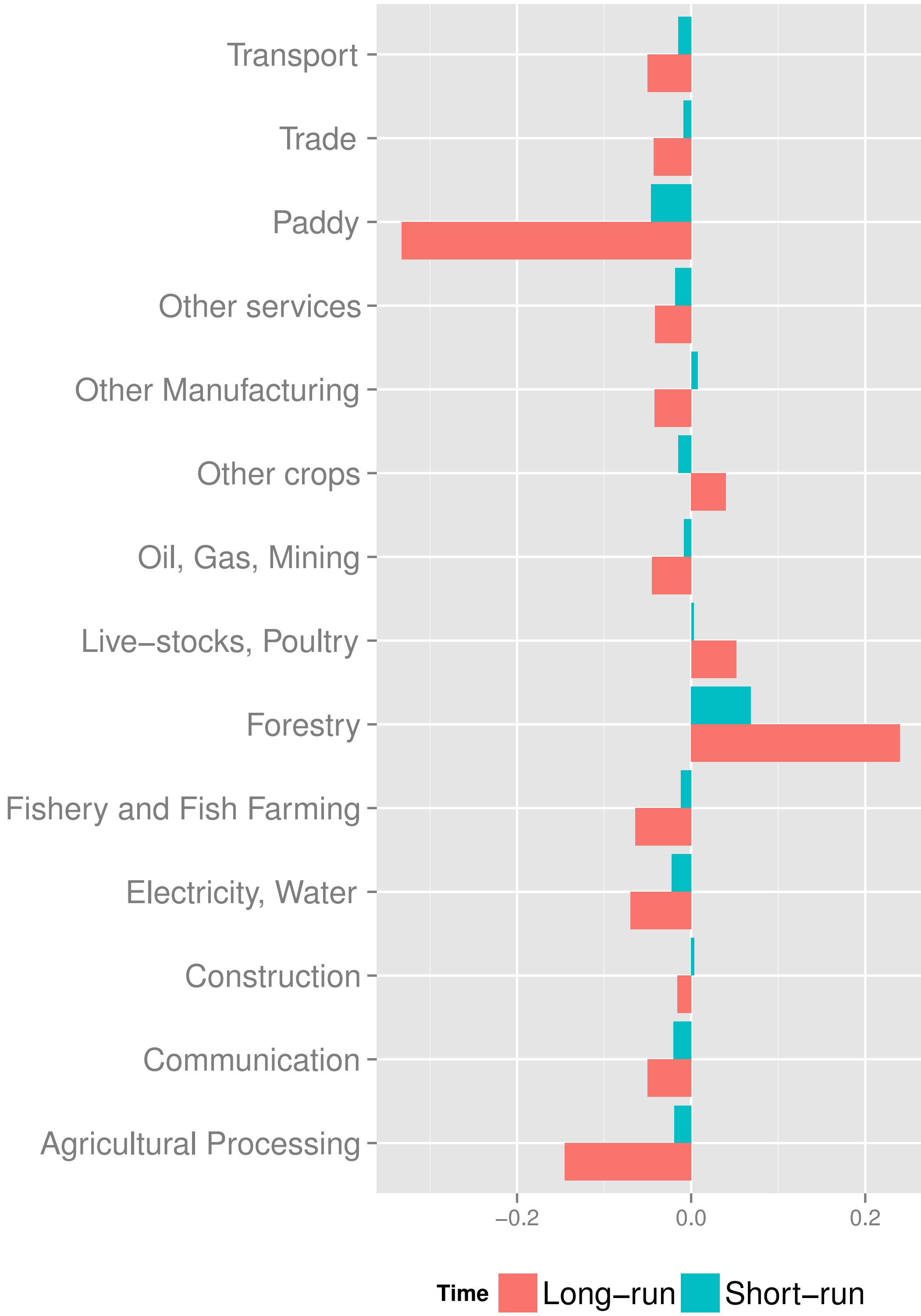
5.4. Export quantity impacts

Unlike imports, Vietnamese export prices are unlikely to be determined by domestic factors (supply) alone. Therefore, we only shock export quantity to reflect the change in world demand for Vietnamese products. Results show that only manufacturing and transport increase in export volume and only in the long-run. As indicated earlier, agriculture will face a tougher export market once all FTAs are in effect (see Figure 9).

5.5. Simulation results

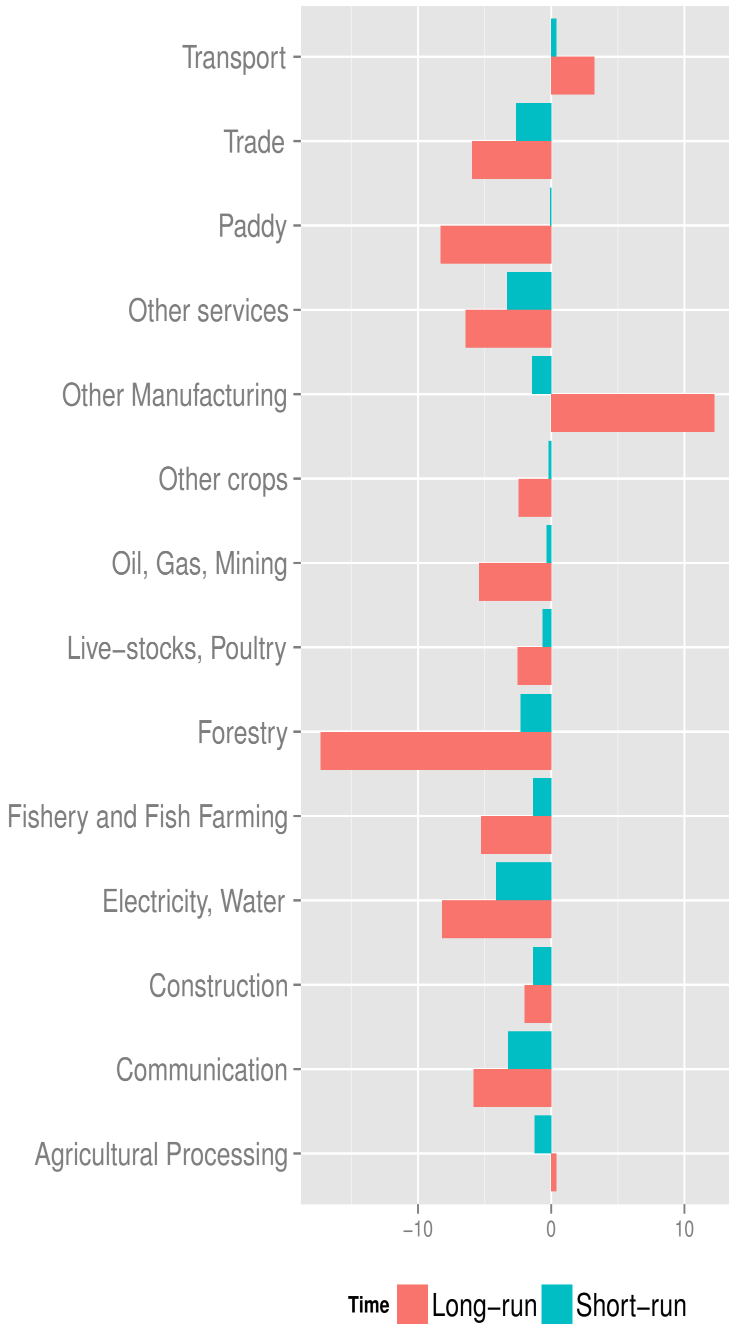
Despite common origins from international industry and commodity classifications, the GTAP and Vietnamese IO table sectors and commodities classification can not be 100% compatible, especially in sub-class divisions. Therefore, we aggregate them down to 14 sectors and commodity classifications to ensure similarity in their predictions. The aggregation narrows the difference to about 0.1%, and both models predict the Vietnamese economy will

Figure 8: GTAP results: Import price shock to Vietnam (% change).



Source: Authors' calculation

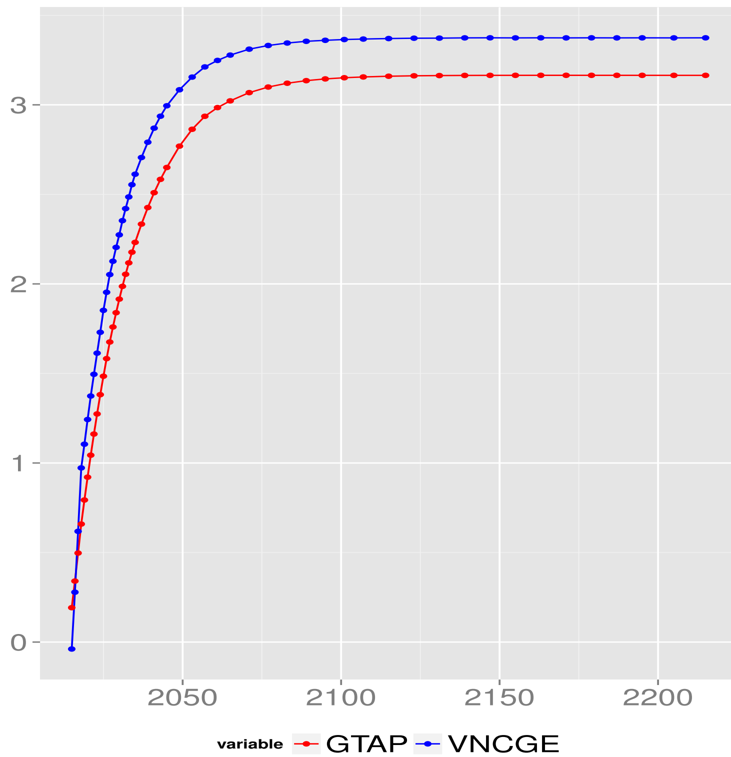
Figure 9: GTAP results: Export quantity shock to Vietnam.



Source: Authors' calculation

increase by approximately 3.2% in the long run[2]. Despite the long-run gain in economic growth, the Vietnamese economy is predicted to face initial difficulties in early years. It takes time for the economy to adjust, to get the full potential of the FTAs.

Figure 10: GDP expansion GTAP vs Vietnamese CGE model.



Source: Authors' calculation.

The economic gain, however, is distributed unevenly between the country's eight regions, with the Red River Delta region benefiting the most and the Mekong River Delta region the least in the list (see Table 4). This might be a surprise, since the two regions are well known for their agricultural performance. However, if we look at the regional economic structure there is a large difference between the two regions. The share of paddy in total regional output in the Mekong River Delta region is 13.33% vs 4.3% in the Red River Delta region. On the other hand, the share of the manufacturing sector is only 14% in Mekong River Delta

[2]Note that due to differences in sectors-commodities classification, the GDP growth rate prediction is slightly lower than 3.37% in the above case of 35 sectors and commodities classification.

region, while its share is 40.84% in the Red River Delta region.

As we have seen before, despite income gains for the country as a whole, the agricultural sector lags behind. The output of the paddy sector first decreases, before recovering moderately with approximately 1/2-1/3 of the increase in income (see Table 5). Output increases the least in Mekong River Delta region in the long run. This partially explains why Mekong River Delta region gains less in terms of economic growth.

Table 4: Change in regional income (%).

	2015	2016	2017	2018	2019	2020	2025	2215
Red River Delta	0.12	0.53	0.97	1.43	1.62	1.81	2.66	4.66
North East	-0.07	0.35	0.75	1.12	1.24	1.36	1.83	2.89
North West	0.27	0.95	1.60	2.21	2.33	2.47	2.98	3.64
North Central	0.27	0.67	1.07	1.47	1.58	1.70	2.19	3.18
South Central	0.05	0.43	0.83	1.23	1.39	1.55	2.26	3.95
Central Highland	0.16	0.75	1.35	1.92	2.04	2.17	2.66	3.54
South East	-0.12	0.10	0.34	0.62	0.75	0.88	1.50	3.23
Mekong River Delta	-0.20	0.12	0.46	0.80	0.89	0.99	1.41	2.27

Source: Authors' calculation.

Table 5: Change in output - paddy (%)

	2015	2016	2017	2018	2019	2020	2025	2215
Red River Delta	-0.25	-0.09	0.09	0.25	0.32	0.39	0.65	1.08
North East	-0.12	0.10	0.36	0.60	0.67	0.76	1.07	1.56
North West	-0.11	0.01	0.16	0.30	0.38	0.46	0.78	1.51
North Central	-0.36	-0.13	0.13	0.36	0.45	0.55	0.90	1.44
South Central	-0.29	-0.16	-0.01	0.13	0.20	0.26	0.55	1.12
Central Highland	-0.05	0.22	0.52	0.82	0.92	1.03	1.44	2.03
South East	-0.11	-0.02	0.09	0.18	0.24	0.30	0.58	1.50
Mekong River Delta	-0.35	-0.13	0.10	0.32	0.39	0.46	0.71	0.87

Source: Authors' calculation.

Model predictions (as we have discussed above) clearly show that some crops win and some lose. With the current aggregation level in this section of the report, the 'other crops' sector as a whole increases moderately in the long run (see Table 6).

Table 6: Change in output - other crops (%)

	2015	2016	2017	2018	2019	2020	2025	2215
Red River Delta	0.02	0.27	0.56	0.84	0.92	0.98	1.19	1.51
North East	0.08	0.36	0.69	1.02	1.10	1.14	1.34	1.54
North West	0.11	0.34	0.61	0.90	0.98	1.04	1.32	1.86
North Central	0.01	0.31	0.64	0.97	1.06	1.11	1.27	1.34
South Central	0.02	0.22	0.45	0.69	0.76	0.79	0.94	1.24
Central Highland	0.03	0.31	0.62	0.94	1.02	1.04	1.08	0.91
South East	-0.01	0.19	0.43	0.66	0.72	0.75	0.92	1.27
Mekong River Delta	-0.08	0.18	0.48	0.78	0.84	0.87	1.00	0.95

Source: Authors' calculation.

Similar to the GTAP model, the Vietnamese model also predicts an expansion in the livestock & poultry sector. The sector expands equally in every region with the exception of the Mekong River Delta region. The expansion of the livestock & poultry sector is induced by increases in domestic consumption demand. Its export performance lags, as we have seen before.

In a manner slightly different from the GTAP model's results, the Vietnamese CGE model predicts a marginal contraction for the fishery and fish farming sector, both in short and long-run, with the exception of South Central region (see Table 8).

Finally, our model predicts no significant unemployment both in the short and long run. Both demand for skilled and unskilled labour increase in the long run (see Table 9). The expansion in the manufacturing sector (especially textiles, see Table 2) absorbs all of the released labour from the more slowly growing agricultural sector.

Table 7: Change in output - Livestocks & Poultry (%)

	2015	2016	2017	2018	2019	2020	2025	2215
Red River Delta	0.77	1.31	1.91	2.53	2.68	2.86	3.48	4.39
North East	0.91	1.53	2.24	2.98	3.15	3.35	4.07	5.09
North West	1.11	1.73	2.43	3.17	3.35	3.58	4.35	5.61
North Central	0.79	1.44	2.16	2.92	3.09	3.31	4.02	4.94
South Central	0.72	1.19	1.73	2.29	2.41	2.58	3.15	4.12
Central Highland	0.87	1.48	2.17	2.88	3.04	3.24	3.91	4.84
South East	0.94	1.45	2.03	2.63	2.76	2.93	3.57	4.71
Mekong River Delta	0.49	1.00	1.57	2.15	2.26	2.41	2.86	3.22

Source: Authors' calculation.

6. Conclusion

Modelling the impact of regional FTAs on Vietnamese regional economies and the agricultural sector is a formidable task. The nature of FTAs requires modelling interactions between all trading partners' economies. At the same time, regional and agricultural sector impact assessments require bottom-up regional economic modelling within the Vietnamese economy itself. To the best of our knowledge, there is no available CGE model for Vietnam built with both international and domestic regional dis-aggregation. To overcome the shortage, we have used two intertemporal CGE models to evaluate the impact of regional FTAs on the Vietnamese economy and agricultural sectors. First, we built an intertemporal version of the GTAP model to analyse interacting economies under FTAs. Second, we improve the Ha and Kompas (2009) Vietnamese intertemporal regional CGE model to determine the impact on regional economies within Vietnam from free trade. We also build a new database for Vietnamese regional intertemporal CGE model.

To solve the (potentially) very large intertemporal regional models, we use the a new parallel-processing solver (Ha and Kompas, 2015). The solver has proven to be very effective and can solve for 45 countries (regions) and 35 commodities in GTAP model, over 51 time periods, with over 70 million endogenous variables.

Table 8: Change in output - Fishery and Fish Farming (%)

	2015	2016	2017	2018	2019	2020	2025	2215
Red River Delta	-0.46	-0.32	-0.19	-0.11	-0.12	-0.15	-0.45	-1.07
North East	-0.30	-0.12	0.05	0.19	0.19	0.18	-0.02	-0.48
North West	-0.39	-0.26	-0.16	-0.09	-0.10	-0.14	-0.50	-1.17
North Central	-0.30	-0.16	-0.01	0.10	0.12	0.13	0.07	-0.15
South Central	-0.18	-0.04	0.12	0.27	0.30	0.33	0.40	0.50
Central Highland	-0.37	-0.20	-0.04	0.08	0.08	0.06	-0.21	-0.82
South East	-0.27	-0.10	0.08	0.23	0.27	0.29	0.31	0.34
Mekong River Delta	-0.45	-0.27	-0.09	0.05	0.06	0.06	-0.09	-0.53

Source: Authors' calculation.

Table 9: Impact on employment (%).

	Short-run		Long-run	
	skilled	unskilled	skilled	unskilled
Red River Delta	0.04	0.06	3.66	3.63
North East	-0.04	0.00	2.11	2.38
North West	0.11	0.13	2.25	2.53
North Central	0.23	0.24	2.41	2.59
South Central	0.04	0.06	2.71	2.81
Central Highland	0.10	0.14	2.11	2.24
South East	-0.20	-0.21	3.77	3.98
Mekong River Delta	-0.26	-0.29	1.91	1.76

Source: Authors' calculation.

Combining the two models allows us to model FTAs impacts internationally and domestically. Additionally, using the output of the intertemporal GTAP model, we can simulate the impact of FTAs using a single country model (the Vietnamese intertemporal regional CGE model) without the omission of the interaction between economies (Vietnam and its trading partners). The simulation results of our model have shown that Vietnam is the 'biggest winner' in the current implementation of FTAs, in which the TPP and EU-Vietnam FTA play an important role going forward. Although the country's GDP will increase with the implementation of regional FTAs, the results for agricultural sectors lag behind considerably. Some agricultural sectors gain, many lose. The export performance prediction, in particular, shows a difficult time ahead for all agricultural commodities. Any gains that accrue usually come from domestic economic expansion (or income gains), not from comparative advantage or international competitiveness. The volume of the export sector for agricultural goods is actually reduced.

In terms of regional income, all regions record positive income growth, with the Red River Delta expected to receive the largest gains. Expansion of the textile sector absorbs labour from the lagging agricultural sector and ensures an increase in employment in Vietnam in long-run.

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Appendix A. List of Countries and commodities in GTAP model

Table A.10: Country and region classification in the GTAP model

ID	Code	Name
1	ase	Indonesia,Philippines,Thaila
2	aus	Australia
3	arg	Argentina
4	bra	Brazil
5	brn	Brunei Darussalam
6	can	Canada
7	chl	Chile
8	chn	China
9	clm	Cambodia,Lao,Myanmar,and Ti
10	deu	Germany
11	fra	France
12	gbr	United Kingdom
13	ind	India
14	ita	Italy
15	jpn	Japan
16	kor	Korea Republic of
17	mys	Malaysia
18	mex	Mexico
19	nzl	New Zealand
20	per	Peru
21	rus	Russian Federation
22	sgp	Singapore
23	usa	United States of America
24	vnm	Viet Nam
25	xac	South Central Africa
26	xca	Central America
27	xcb	Caribbean
28	xcf	Central Africa
29	xea	Rest of East Asia
30	xec	Eastern Africa
31	xee	Rest of Eastern Europe
32	xef	EFTA
33	xer	Rest of Europe
34	xeu	Rest of EU
35	xna	Rest of North America
36	xnf	North Africa
37	xoc	Rest of Oceania
38	xsa	Rest of South Asia
39	xsc	South African Customs Union
40	xsm	Rest of South America
41	xsu	Rest of Former Soviet Union
42	xtw	Rest of the World
43	xwf	Western Africa
44	xws	Western Asia

Table A.11: List of commodities in the GTAP model.

ID	Commodity code	Commodity name
1	pdr	Paddy rice
2	wht	Wheat
3	gro	Cereal grains nec
4	v_f	Vegetables, fruit, nuts
5	osd	Oil seeds
6	c_b	Sugar cane, sugar beet
7	pfb	Plant-based fibers
8	ocr	Crops nec
9	ctl	Bovine cattle, sheep and goats, horses
10	oap	Animal products nec
11	rmk	Raw milk
12	wol	Wool, silk-worm cocoons
13	frs	Forestry
14	fsh	Fishing
15	cog	Coal, Oil, Gas
16	pcr	Processed rice
17	sgr	Sugar
18	fpr	Food processing
19	omn	Mining
20	tal	Textiles
21	pap	Paper
22	woo	Wood
23	rub	Rubber
24	nmt	Non-Metallic Mineral Products
25	tre	Transport Equipment
26	met	Metal Products
27	oma	Other Manufacturing
28	egw	Electricity, Gas, Water
29	cnt	Construction
30	tra	Transport
31	com	Communication
32	thr	Trade, Hotels, Restaurants
33	fis	Financial services
34	pub	Public Administration
35	osr	Other Services

Appendix B. List of commodities in VNCGE model

ID	Code	Name
1	pdr	Paddy
2	ocr	Other crops
3	liv	Livestocks and Poultry
4	for	Forestry
5	fis	Fishery and Fish Farming
6	ogm	Oil, Gas, Mining
7	apr	Agricultural Processing
8	oma	Other Manufacturing
9	ewg	Electricity, Water
10	cst	Construction
11	trn	Transport
12	com	Communication
13	trd	Trade
14	ser	Other services